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Former Syncrude Researcher Sees Oilsands Opportunity For Upgrading Commercialized In China

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BY PAT ROCHE (/AUTHOR/PAT-ROCHE/) – FEB. 5, 2018 – VIEW ISSUE (/HEADLINES/2018-02-05)

Converting semisolid bitumen to refinery-ready light crude has always been called “upgrading,” but the co-inventor of a different approach says traditional upgrading should be called “downgrading.”

That's because thermal cracking of crude oil produces a product with a lower hydrogen-to-carbon ratio, says **Keng Chung**, co-inventor of what he calls a physical separation process.

Chung is vice-president of Edmonton-based **Well Resources Inc.** which is promoting a process for both decreasing bitumen viscosity and converting it to a product more refineries can accept. Selective extraction of asphaltenes, or SELEX-Asp, is a solvent-based physical separation process capable of selectively extracting asphaltenes as dry granulates.

"A lot of these partial upgrading [technologies also] decrease the hydrogen-to-carbon ratio. I call it downgrading," Chung told the *Bulletin*.

"They need to have some kind of hydrogenation process. … It doesn't make sense because all this hydrogen process is already at the refinery," he said, noting that much of traditional upgrading duplicates what happens at refineries.

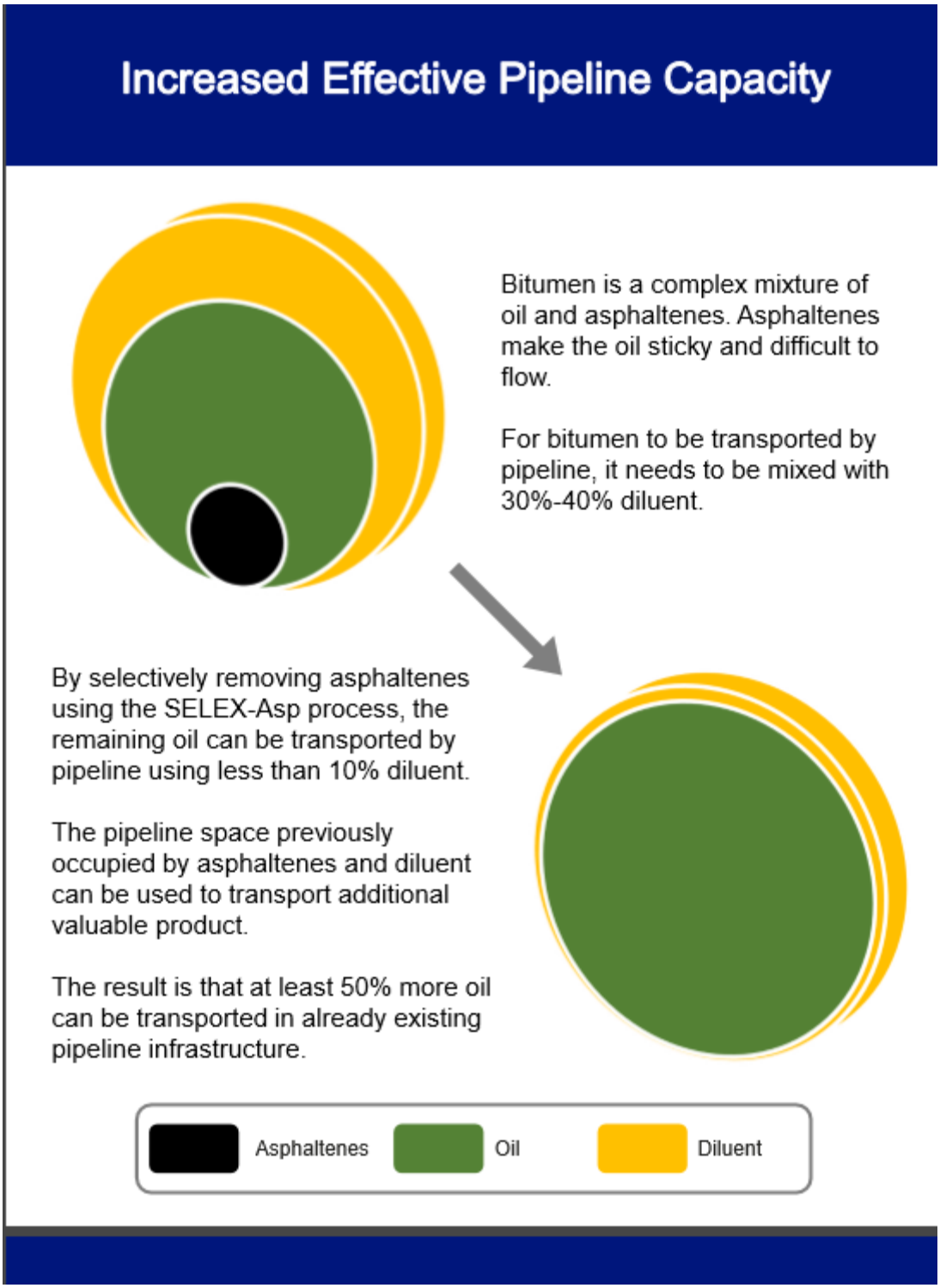
Well's approach is to simply extract the asphaltenes and leave refining to the refineries.

"We don't do anything related to so-called upgrading or refining," Chung said. "We simply do separation."

Light crude oil, which has a higher hydrogen-to-carbon ratio than heavy oil, fetches a premium price. Hence Chung's description of thermal cracking of crude oil, which produces a product with a lower hydrogen-to-carbon ratio, as downgrading.

Chung, who holds a doctorate in engineering from the **University of Calgary**, began his career in oilsands research. He recalls being the first doctoral student of **Roger Butler**, who patented the SAGD concept that revolutionized in-situ oilsands production. Chung worked at **Alberta Oil Sands Technology and Research Authority** (AOSTRA), an industry/government collaboration that funded much of the research and development that led to SAGD.

Today, Chung spends about half of his time in Canada and the rest in Beijing, Qingdao and Guangzhou as a refining adviser to the Chinese government. His focus is value-added byproduct utilization. He is also a distinguished professor of chemical engineering at the **China University of Petroleum** and **Guangdong University of Petrochemical Technology**.



Canada-China collaboration

The Canadian researcher's collaboration with heavy oil researchers in China began about 25 years ago when he was at **Syncrude Canada Ltd.** His Canadian achievements were honoured with a 2002 Alberta Science and Technology (ASTech) award (http://www.astech.ca/archives/indexofpastwinners/chung-dr-keng-h) for oilsands innovation.

In 1997 when he was still at Syncrude, Chung and three researchers at China's **University of Petroleum** in Beijing published a paper (http://www.ogj.com/articles/print/volume-95/issue-3/in-this-issue/petrochemicals/supercritical-fluid-extraction-reveals-resid-properties.html) in the Jan. 20, 1997 *Oil & Gas Journal* on supercritical fluid extraction. Their work would eventually borrow an idea from the food industry and adapt it to heavy oil processing.

SELEX-Asp is a supercritical solvent extraction process. SELEX, or selective extraction, was commercialized in the 1940s to make decaf coffee, and is widely used today in the food and pharmaceutical industries.

In the 1980s the **State Key Laboratory of Heavy Oil Processing** at China's **University of Petroleum** began adapting supercritical solvent extraction to petroleum applications. Initially, it was just used to better understand heavy oil chemistry. Later, it was scaled up for commercial application as SELEX-Asp, or selective extraction of asphaltenes.

With the supply of available conventional crude dwindling at the start of this century, **PetroChina** did a feasibility study on using SELEX-Asp to optimize the value of vacuum resid. Bench-scale lab tests were done using a one-bbl/d unit. (Well says it later piloted units of up to 300 bbls/d.)

Patent granted

Successful lab testing convinced PetroChina to build a 500-bbl/d field demonstration unit at its Panjin refinery in northeast China in 2009, the same year Chung and five co-inventors at the China University of Petroleum-Beijing were granted a U.S. patent (https://docs.google.com/viewer?url=patentimages.storage.googleapis.com/pdfs/US7597794.pdf).

According to the patent, their invention uses atmospheric pressure and a low-temperature gas/solid separator instead of a high-temperature and high-pressure furnace, and it doesn't require feed pre-heating or heat exchange equipment at the inlet of resin separator column. This reduces cost and complexity.

Chung, four colleagues from the China University of Petroleum and a PetroChina engineer published a paper (http://www.ogj.com/articles/print/volume-108/issue-12/technology/china-refinery-tests.html) on their process in the April 5, 2010 *Oil & Gas Journal*. And in a paper (http://www.ogj.com/articles/print/volume-114/issue-6/processing/asphaltenes-extraction-treatment-yields-advantaged-hydroprocessing-feedstock.html) published in the June 6, 2016 *Oil & Gas Journal*, Chung, two colleagues from **North Huajin Chemical Industries Group Corp.**, Panjin, China, and five researchers from the University of Petroleum, Beijing, concluded that tests of Canadian bitumen in China using SELEX-Asp to pre-treat vacuum residue produces a cost-effective and environmentally compliant refinery feedstock.

Vacuum residues and bottom streams that would otherwise be discarded can now serve as feedstock for SELEX-Asp treatment, yielding more refinery feedstock, the paper said.

"At current global crude-consumption rates of 95 million bbls/d, the authors estimate SELEX-Asp processing technology could provide conventional refineries an additional five million bbls/d of feedstock for production of cleaner fuels," the paper concluded.

Operating in China

Not counting the 500-bbl/d unit built at PetroChina's Panjin refinery in 2008 (a demonstration unit which is not operated continuously), Well says it has built four SELEX-Asp units in China with a combined capacity of 36,000 bbls/d.

The company says those include a 4,000-bbl/d unit commissioned in 2014, a 20,000-bbl/d unit commissioned in 2015, a 4,000-bbl/d unit commissioned in 2015 and an 8,000-bbl/d unit expected to be commissioned this year.

Well says the 20,000-bbl/d unit is installed at a resid refinery which buys vacuum resid and processes the cleaned resid into gasoline and diesel.

The Alberta company says the two 4,000-bbl/d SELEX-Asp units and the 8,000-bbl/d unit are installed at small "teapot" refiners that take vacuum resid from large refiners, clean it up, and then sell it back to them as a value-added feedstock.

Well says the small refineries are owned by independent for-profit companies in China, not state-owned enterprises.

Focus on Canada

The Edmonton-based company is now refocusing on Canada. It claims the deployment in China has de-risked the technology, so there's no need to do a pilot in Canada.

Chung said representatives of Alberta oilsands producers have travelled to China to visit refineries where SELEX-Asp is installed, but declined to name them, citing confidentiality.

"This has allowed us to go straight into commercial licensing discussions, bypassing the need to pilot in Canada," said **Warren Chung**, a professional engineer, president of Well, and Keng Chung's son.

Keng Chung pointed out the SELEX-Asp separation process is much simpler than coking, and would cost a lot less. Asked whether the technology should first be piloted in Alberta to test performance during Alberta's harsh winters, he said the climate in northeast China, where the technology is operating, is similar to Alberta's.

How it works

SELEX-Asp is a physical separation process (as opposed to a thermal or catalytic process) that uses a solvent at supercritical operating conditions to make asphaltenes precipitate out of the vacuum residue.

Vacuum resid is mixed with a solvent, such as pentane, heated and then sent to a proprietary extractor. Solid asphaltenes are discharged as dry granulates.

Well says SELEX-Asp's solvent-to-oil ratio is typically four to one while conventional deasphalting technologies have solvent-to-oil ratios ranging between five to one and eight to one.

SELEX-Asp operates at a much lower temperature than conventional bottoms processing methods such as coking and hydroprocessing. Well says SELEX-Asp would have lower capital costs, lower energy use, greater reliability and a lower yield of heavy byproducts.

In the refining process, about 40 per cent of Alberta's notoriously heavy bitumen ends up as vacuum residue.

"Research has shown that asphaltenic material is the biggest driver of downstream refining issues and [it] greatly contributes to the viscosity of bitumen," said Warren Chung. "Our solution is simply to cleanly remove these troublesome components up front—before you spend time and energy heating them up and cooking them, trying to break them."

Small scale

Well says SELEX-Asp can be added to an existing refinery, or implemented near the production source.

Technically, there's no limit on how small a volume the SELEX-Asp separation process could handle, but that would be determined by local economics, Keng Chung said.

"In China we know we can do 4,000 to 20,000 [bbls/d], no big deal. But in Canada you can't because our labour costs are so high," he said. "… In Canada I don't think anybody can be exact about the real number [but] I think we can do 10,000 [bbls/d] up."

Hence, a SELEX-Asp separation unit could be added to a 10,000-bbl/d well pad.

Less diluent, wider market

An economic handicap for the Canadian oil industry is that major pipelines out of the basin are essentially full and it will take a few years to get new ones built. Shipping by rail costs more.

Deasphalting would free up pipeline capacity in two ways.

First, less diluent would be needed. “If, say, a pipeline has 100,000 [bbls/d] capacity … in actual fact you only send 70,000 bbls of bitumen and 30,000 bbls of diluent,” Keng Chung said.

But if asphaltene-free bitumen was shipped, the amount of diluent required would be reduced to nine per cent, compared to roughly one-third for untreated bitumen, Well says.

Second, asphaltene rejection means a waste product wouldn’t be taking up pipeline space. Tests by Chung and four colleagues at China’s University of Petroleum found Athabasca bitumen treated by SELEX-Asp had an 84 per cent yield, based on weight (Petroleum Technology Quarterly, Q4 2006 (http://www.eptq.com/view_article.aspx?intAID=719)).

But while SELEX-Asp had a lower yield, deasphalted crude would command a higher price and could be processed by a wider range of refineries. The same tests using SELEX-Asp converted 7.8-degree API bitumen to 13 API. In other words, an ultra-heavy crude was converted to a higher-value heavy crude.

While the Chungs know they are competing with more than a dozen partial upgrading technologies proposed for the oilsands, they hope SELEX-Asp’s commercial deployment in China will give them an edge over competitors who haven’t yet progressed beyond the commercial demonstration phase.

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